

The Nolidae (Lepidoptera) of Israel

by

GÜNTER C. MÜLLER¹, VASSILIY D. KRAVCHENKO², CHUANG LI¹, JOSEF MOOSER³,

OLGA B. ORLOVA², WOLFGANG SPEIDEL⁴ & THOMAS WITT⁴

received 23.III.2005

1: Department of Parasitology, Kuvin Centre for the Study of Infectious and Tropical Diseases,
The Hebrew University – Hadassah-Medical School, Jerusalem, Israel.

2: Department of Zoology, Tel Aviv University, Tel Aviv, Israel.

3: Seilerbruecklstr. 23, D-85354 Freising.

4: Museum WITT, Tengstr. 33, D-80796 München.

Corresponding author: Dr. G. C. MÜLLER: Muller@md.huji.ac.il

Abstract: The distribution, flight period and abundance of the ten Israeli Nolidae species are summarized. *Meganola gigantula* (STAUDINGER, 1878), *Meganola albula* ([DENIS & SCHIFFERMÜLLER], 1775), *Nola cucullatella* (LINNAEUS, 1758) and *Nola harouni* (WILTSHIRE, 1951) are new records for the Israeli fauna. The distribution, phenology, ecology, abundance and the association to the main phyto-geographical zones of Israel is also described.

Zusammenfassung: Die Verbreitung, Flugzeit und Häufigkeit von 10 israelischen Nolidae-Arten wird zusammenfassend behandelt. *Meganola gigantula* (STAUDINGER, 1878), *Meganola albula* ([DENIS & SCHIFFERMÜLLER], 1775), *Nola cucullatella* (LINNAEUS, 1758) und *Nola harouni* (WILTSHIRE, 1951) werden erstmals für die Fauna Israels nachgewiesen. Die Verbreitung, Phänologie, Ökologie, Häufigkeit und die Zuordnung der Arten zu den phyto-geographischen Großgebieten von Israel wird diskutiert.

Material & Methods: Within the Israeli-German project for the study of the Israeli Lepidoptera fauna, intensive collecting was conducted from 1986-2004. This project was a joint effort of The Hebrew University, Tel Aviv University, The Nature Reserves and Park Authority of Israel, the Zoologische Staatssammlung Munich, Germany and Museum WITT, Munich, Germany. Lepidoptera were collected during a period of 18 years totaling about 3000 nights of mobile light traps powered by generator (250 Watt bulbs HQL & ML) and about 1500 nights of mobile light trap systems powered by batteries (12Volt 8 Watt & 20 Watt, 6 Volt 4 Watt Black light UVB tubes) moved on a daily basis. Additionally an intensive network of permanent light traps (220 V 20 W Black light UVB & UVC tubes) was maintained. Traps were relocated on an annual basis. From year to year 10-34 traps were operated.

Introduction: Israel is located at the eastern part of the Mediterranean Basin in the northern part of the Syrian East African Rift Valley (PICARD, 1943). The character of the country is mainly determined by the position within the Mediterranean zone as crossroads between three continents and two oceans and by being a boundary of cultivated land and desert (POHORYLES, 1975). In consequence of the alternating geographical and climatic zones of Israel are common ground

for plants and animals of different origin and they also constitute the furthest point of geographical distribution of many species (FURTH, 1975; JAFFE, 1988).

Israel is located in the 20°C isotherm of annual temperature (ASHBEL, 1951). However this is only true for the Coastal Plain (BIEL, 1944) since in the hills there is an annual average of 17°C, and in the Jordan valley of 25°C (ASHBEL, 1951). As a rule temperatures drop abruptly in November, and reach a minimum in January or February. Days with freezing point occur almost every winter in the Hills and they are rare in the Coastal Plain. The warming in April and May is more gradual than the drop of the temperature in autumn. In summer peak temperatures fluctuate around 40°C (ASHBEL, 1951). The winter is short and almost 70% of the annual rainfall occurs between November and February. Rain from May to September is rare and negligible and the dry season is from June to August. The annual rainfall decreases from 1500 mm on Mt Hermon in the north to 15 mm near the golf of Eilat in the south (ASHBEL, 1951).

The plants of Israel belong to five large phyto-geographic regions (ZOHARY, 1966): Terminology of the phyto-geographical zones was developed by EIG (1926), modified and adapted by ZOHARY (1972). These major zones are Mediterranean, Irano-Turanian, Saharo-Arabian, Tragacanth and Ethiopian.

The Mediterranean temperate Zone covers those areas which receive an annual average precipitation of 350 mm or more (ZOHARY, 1962). The Mediterranean vegetation is divided into two distinct types: That of the hills and that of the Coastal Plain. In the hills with its higher precipitation (about 500-700 mm) maquis is dominant (BIEL, 1944). Today, most of the Coastal Plain consists of agriculture areas and human habitation (KOSSWIG, 1955).

The Irano-Turanian Zone, a semi arid area, is a dry steppe or desert steppe which stretches from its south west border in Israel through Iran, Turkistan and inner Asia to the Gobi desert. The average annual rainfall is 200-300mm during winter only. Low brush or dwarf bushes with *Artemisetum* plant associations are characteristic for this region (ORNI & EFRAT, 1980; ZOHARY, 1972).

The Saharo-Arabian eremic zone is a true desert which centers on the Arabian Peninsula. Winter rainfall of less than 200 mm is followed by a short period of blooming, and afterwards the vegetation dries rapidly up (BODENHEIMER, 1935). The vegetation is very sparse averaging over large areas in one plant per one to ten square meters (KUGLER, 1988).

The Ethiopian tropical zone in Israel is only represented in small enclaves in the lower Jordan valley, the Dead Sea area and the Arava Valley where they are surrounded by extreme desert or halophytic vegetation (BYTINSKI-SALZ, 1961). High temperature, abundant fresh water and rich soil conditions are typical of these oases (ZOHARY & ORSHANSKY, 1949).

The Tragacanth high altitude zone is restricted to the peak of Mt Hermon (above 1900 m). Snow coverage with very low temperatures in winter and hot, dry summer create specific plant communities dominated by spiny, round, dense, cushion like shrubs such as *Astragalus* and *Onobrychis*. The main water source in this area is melting snow, consequently most of this karstic mountain area is rather arid. Different types of forest are only found along the foot hills and within canyons (JAFFE, 1988).

Worldwide there are nine subfamilies, 308 genera, and about 1400 species of Noliaceae s. l. (KRISTENSEN, 1999). Most of the species are found in the tropics while in the West Palearctic Region only 19 species of Nolinaceae are found (DE FREINA & WITT, 1987); ten species

are now known to occur in Israel. The Nolinae are traditionally treated as a separate family (Nolidae s. str.). Nolids have been for a long time 'taxonomically shuffled' between the Arctiidae and Noctuidae and only recently have synapomorphic characters been recognized (KITCHING & RAWLINS in KRISTENSEN, 1999; SCOBLE, 1992).

In the early 20th century, five species of Nolinae were known from Israel and summarized by AMSEL (1933, 1935a, 1935b). Since then only one further species has been added (BYTINSKY-SALZ & STERNLICHT, 1967). In this survey, all previously known species and an additional four new records are summarized.

Faunistic Survey

Meganola togatalis (HÜBNER, 1796)

This species was only found in the Mediterranean zone. It was generally common and wide spread in the Golan Heights and the Mediterranean Hills, in the Coastal Plain it was uncommon and local. The habitat of this species were all kind of oak forests where it was mainly found on south exposed karstic slopes with sparse vegetation. On northern slopes or shady canyons with dense vegetation it was uncommon or absent. On Mt Hermon it penetrated the Tragacanth zone and was found up to the peak (2200 m). There are no records from habitats without *Quercus* (Fagaceae), *Crataegus*, *Amygdalus*, *Prunus*, *Rubus* (Rosaceae) bushes.

Adults were observed from mid-April to the end of October. It was common from May to August. Most of the records were from miniature UV light traps. Specimens attracted to strong light sources (as used with generators) tended to rest several meters away from the light in the nearby vegetation or on the ground.

Larvae were observed mid-June west of Jerusalem and mid-July in the western Galilee on bushes of *Quercus boissieri* (REUT.) and end of September on the northern Golan Heights on *Quercus calliprinos* (WEBB.) trees. In all three locations numerous larvae were seen after mid-night at a height of 0,5-1,5 m on the underside of young leaves. BYTINSKI-SALZ & STERNLICHT (1967) observed the species on *Q. ithaburensis*. Larvae reared in the laboratory pupated in cocoons attached to branches in end of June and hatched in the first week of September. In captivity larvae accepted readily leaves of *Amygdalus communis* and *Rubus sanguineus*. On Mt Hermon (1600 m) larvae were seen by KRAVCHENKO & MÜLLER feeding on *Crataegus azarolus*. In Israel it is apparently feeding polyphagous on bushes and trees of *Quercus* (Fagaceae) and a variety of Rosaceae species. The species has at least two overlapping generations, possibly a partial third generation in the lower Mediterranean foot Hills.

Meganola strigula ([DENIS & SCHIFFERMÜLLER], 1775)

The species was only found in the Mediterranean Zone, in the Upper Galilee. The last twenty years only one ♂ was collected near Kibbutz Dan in early September 1986 by MÜLLER & ORTAL, in the riverside forest of the Dan, in a shady location dominated by *Populus*, *Salix* and *Eucalyptus* trees with thickets of *Rubus*.

In the early sixties several larvae of the species were collected by BYTINSKY-SALZ & STERNLICHT (1967) on bushes of *Quercus calliprinos* and *Q. ithaburensis* in mid-May near the two Jordan springs Dan and Banjas. Adults hatched in the same year during August and September. The occurrence of the species is not clear. Possibly the rarity of the species is based on avoiding light

sources. Though we have thousands of trapping nights from this area we have only one adult record in contrast to the fact that the local population seems to be easily found on oaks as larvae.

Meganola albula (DENIS & SCHIFFERMÜLLER, 1775)

This is a new record for the fauna of Israel.

The species was rare and local in the Mediterranean zone in the Upper Galilee. So far this species was only found in the Hula Valley in the Tel Dan Nature Reserve (River Jordan Springs) and the Hula Nature Reserve (former Hula swamps). The habitats of this species were wet, swampy meadows in the vicinity of water. All specimens were collected with Miniature CDC light traps, as used for mosquito surveys, in thickets of *Rubus*, *Mentha* and *Phragmites*. It is worthwhile mentioning that this species is known to feed in Europe polyphagous on herbivorous plants among others also on *Rubus* and *Mentha* (DE FREINA & WITT, 1987). It was never collected in one of the larger traps or with strong light sources. All records were byproducts of mosquito surveys. Records from the Jordan Springs were from late August 1989 by ORTAL & MÜLLER and mid-July 1991 by the Entomological Laboratory Ministry of Health. From the Hula reserve single specimens were collected mid-June 1994, late August 2001 and mid-June 2004 all by the staff of the Ministry of Health.

In the last 20 years 10 thousands of CDC light trap catches from all kind of wetlands were conducted nationwide to monitor mosquito populations. From most of these catches the Lepidoptera were retrieved. This species seems to be restricted in Israel to natural wetlands in the Hula Valley.

Meganola gigantula (STAUDINGER, 1878)

This is a new record for the fauna of Israel.

The species was very rare and local in the Mediterranean zone in the Lower and Upper Galilee. Two males were collected by MÜLLER & ORTAL (2 km east of Zefat 600 m) late April 1987. One was collected east of Nazareth 500 m by LI & MÜLLER mid-August 1995. The moths were collected with CDC traps and not with 250 Watt HQL bulbs powered by a generator operated near by. No specimens could be collected in additional hundreds of miniature light trap catches in the same area. Both locations were south exposed slopes loaded with scattered lime rocks with very sparse grassy vegetation and some small *Quercus* sp., *Rosa* sp. and *Crataegus* sp. bushes. The two records from spring and summer suggest that the species flies in two generations.

Antennola impura wiltshirei (WARNECKE, 1939)

This species is uncommon but wide spread in the Mediterranean Coastal Plain, Hills and additionally in the Irano-Turanian zone. All records were from miniature light traps in which they were collected around mid-night or later.

Records from the Mediterranean were from the Upper and Lower Galilee, the Golan Heights, Samaria, Shefela, Judean Mts., Mt. Carmel and the Philistean Plain. In this region the species was found in two generations from April till early October. Most records are from late April and May, July and August with a partial third peak September and October. In the Irano-Turanian zone records started in early March and ended in mid-October. Records were from the Beit Shean Valley, Upper Jordan Valley, Northern Negev and the Judean Desert east of Jerusalem. This species inhabits a large variety of biotopes in Israel, no specific preferences were detected.

The data suggest that it occurs in Israel in three generations with the highest population density in the second generation.

***Nola cucullatella* (LINNAEUS, 1758)**

This is a new record for the fauna of Israel.

The species was restricted to the Mediterranean zone. It was very rare and local in the Judean Mts. One ♂ was collected by MÜLLER & ORTAL 1989 (5 km west of Jerusalem 600 m) early April and a second ♂ by KRAYCHENKO & MÜLLER twelve years later near by (about 10 km west of Jerusalem 500 m) mid-April. In both cases the habitats were on north facing slopes with oak maquis of low height, *Crataegus* sp. thickets, groups of *Pinus halepensis* (MILL.) and some *Juniperus* sp. bushes.

***Nola harouni* (WILTSHIRE, 1951)**

This species was wide spread in the Mediterranean and penetrated locally in the Irano-Turanian zone. It was always rare. Records came from the Upper Galilee Kibbutz Yftah, the Lower Galilee near Nazareth, around the Sea of Galilee, the southern Golan Heights, from the Hula Valley, the Judean Mts. around Jerusalem, Samaria near Shechem, the Judean Hills near Shefela Beit Shemesh and the Jordan Valley south of the Sea of Galilee.

Material which was collected by MÜLLER & KOTITSA north of the Sea of Galilee from the River Jordan Park in Israel, early June 1987, was published by HACKER & SCHREIER (2001a) as a record for Israel, in a further publication about the Levant the same specimen was attributed by HACKER (2001b) to Jordan declaring it absent from Israel.

In Israel most of the records were from the Mediterranean zone. The habitats ranged widely from shady narrow canyons with dense vegetation to south exposed slopes with sparse vegetation cover. Along the Sea of Galilee and in the Jordan Valley this species penetrated the Irano-Turanian zone. There were no records from the arid parts of the Irano-Turanian zone or the desert. Records were from April to September without a pronounced peak.

***Nola squalida* (STAUDINGER, 1870)**

Though this species was wide spread in the Mediterranean, Irano-Turanian and Sudanian zone it was always rare. Records from the Mediterranean came from canyons, mainly north facing slopes, with dense vegetation often along streams and springs; from the Irano-Turanian zone all records were from canyons with permanent streamlets; in the Ethiopian zone it was only found in oasis along the Dead Sea and the Lower Jordan Valley (BODENHEIMER, 1939). In the Saharo-Arabian zone only few records of single specimens were collected in the last 20 years in the Western Negev in the area of Nizzana all during spring time.

Records were from mid-March to November at Mediterranean sites; in the Rift Valley it was found the year round.

Known food plants in Israel are *Quercus calliprinos* and *Q. ithaburensis* (BYTINSKI-SALZ & STERNLICHT 1967; HALPERIN & SAUTER, 1991). Possible food-plants outside the Mediterranean zone are unknown; WILTSHIRE (1957) suggested *Tamarix* sp.

***Nola subchlamydula* (STAUDINGER, 1870)**

This is a new record for the fauna of Israel.

Uncommon but wide spread in the Mediterranean and in the Irano-Turanian zone. In the Mediterranean most records were from grassy south exposed slopes with few or no bushes. It

was also found in the dense river forest of the Western Galilee. In the Irano-Turanian zone the species was collected in shady canyons with water and also on hot south exposed slopes with occasional patches of vegetation. This species seems to prefer no specific type of habitat in Israel. Nevertheless it was never found in the Saharo-Arabian zone even not in oases in the southern Rift Valley. Records were from late March to early November with well pronounced peaks in April mid-May, early July to mid-August and a partial peak, only in lower elevation, around October.

***Nola chlamitulalis* (HÜBNER, 1796)**

This species was rare and local in the Mediterranean and in the Irano-Turanian zone. In the Mediterranean it was seen in rather dense oak maquis on the northern slopes of the Carmel mountain ridge, in park forests of the Upper and Lower Galilee, in the Judean Mts. in shady canyons west of Jerusalem preferably in locations near springs and creeks within thickets of *Rubus*. It was less common on karstic south exposed slopes with single bushes of *Quercus* and *Crataegus* or in areas planted with *Pinus*. The Irano-Turanian zone was penetrated along streamlets in deep canyons which drain into the Jordan River.

Only one ♂ was found in the Central Negev on Har Negev (900 m) in mid May 1994 by MÜLLER & KOTITSA. The habitat was a north exposed, not very shady, slope with large dense patches of grass between numerous scattered rocks and some bushes of *Rhus tripartita*, *Nitraria retusa* and *Alhagi* sp. There were no records from the Saharo-Arabian zone or from oases in the Rift Valley. Records are from end of February to early October with a pronounced peak in March April and in September.

Discussion: Nine of the ten Nolinae of Israel are of a Mediterranean distribution type [*M. togatalis* (HBN.) and *N. cucullatella* (L.), Circum Mediterranean European; *M. strigula* (D. & S.) and *M. albula* (D. & S.), North Mediterranean European; *N. subchlamydula* (STGR.) and *N. chlamitulalis* (HBN.), Circum Mediterranean; *M. gigantula* (STGR.), East Mediterranean; *A. impure wiltshirei* (WARNECKE), East Mediterranean Central Asian; *N. harouni* (WILTSHIRE), East Mediterranean Arab Peninsula]. *N. squalida* (STGR.) is distributed paleotropical. From many insect families the bulk of the species are found in the Mediterranean zone (AVIDOV & HARPAZ; KUGLER, 1989). In the arid areas of the Arab Peninsula and the Levant only few Nolidae are found (WILTSHIRE, 1948; 1951; 1990).

Accordingly all species were mainly found in the Mediterranean vegetation zone in Israel. Four species were restricted to it and an additional three were centered in the Mediterranean but penetrated a neighboring zone (one Tragacanth, two Irano-Turanian). Three species were widely distributed in the Mediterranean and Irano-Turanian zone. The only species that was found in Mediterranean forests as well as grassland, tropical oases and even in the desert was the paleotropical *N. squalida* (STGR.).

Generally this family was retrieved from miniature light traps only very few records were obtained with light sources of 20 Watt or more. This could be one of the reasons why in the past only few species, always in low numbers, were collected. Nevertheless seven of the ten local species were rare and four of these were also local during this widespread survey.

Tab. 1: The distribution and abundance of Noliniæ in Israel associated with the major phyto-geographical zones

<i>Species</i> <i>status, distribution & abundance</i>				<i>Major Phyto-geographical Zone</i>				
				<i>Mediterranean</i>	<i>Irano-Turanian</i>	<i>Saharo-Sindian</i>	<i>Ethiopian</i>	<i>Tragacanth</i>
<i>togatulalis</i>	<i>N</i>	<i>L</i>	+++	XXX				XX
<i>gigantula</i>			<i>R</i>	XXX				
<i>strigula</i>		<i>L</i>		XXX				
<i>albula</i>	<i>N</i>	<i>L</i>	<i>R</i>	XXX				
<i>impura wiltshirei</i>			+	XXX	XXX			
<i>maculatella</i>	<i>N</i>	<i>L</i>	<i>R</i>	XXX				
<i>harouni</i>			<i>R</i>	XXX	XX			
<i>squalida</i>			<i>R</i>	XXX	XXX	X	XXX	
<i>subchlamydula</i>	<i>N</i>		+	XXX	XXX			
<i>chlamitulalis</i>			<i>R</i>	XXX	XX			

New record for Israel

N

Species not collected for at least 50 years

O

Distribution within phyto-geogr. Zones

XXX Main area of distribution

XX Area of penetration

X Sporadic records

Abundance & Distribution

++++ Abundant (more than 500 specimens recorded per year)

+++ common (100 to 500 specimens recorded per year)

++ Fairly common (20 to 100 specimens recorded per year)

+ Uncommon (5 to 20 specimens recorded per year)

R Rare (less than 5 specimens recorded per year)

L Local (only in one Zone and there in 3 or less locations collected)

Acknowledgement: We thank all our colleagues and the many generous Israeli citizens who helped with this survey. We are grateful to the Israeli Nature and Parks Authority (NPA), who supplied the collecting permits, especially to Dr. RUEVEN ORTAL, Dr. DIDI KAPLAN (NPA Northern District Biologist), to Mr. YIFTAH SINAI (NRA Carmel District Biologist), Mr. ZEEV KULLER (Central District Biologist), Mr. AMOS SABAH (Yosh District Biologist), the late Dr. DAFNA LAVEE (former Southern District Biologist) and Mr. DROR HAWLENA (current Southern Biologist), Dr. RONI KING (former) and Dr. BENNI SHALMON (current Eilat District Biologist) and the staff of the NPA-regional rangers, Nature Reserves and National Parks directors thorough out Israel. Furthermore we thank Prof. J. KUGLER, Dr. A. FREIDBERG (Entomological collection, University of Tel Aviv) and Prof. J. FITTKAU (former Head of the Bayrische Zoologische Staatssammlung Munich Germany), Dr. HEDVA PENER, Dr. LAOR ORSHAN and Dr. HEATHER BROMLY-SCHNUR (Entomological Laboratory, Ministry of Health), the late Dr. SHOSHANA YATOM (Volcani Center, Bet Dagan), Mr.

YOSSI LEV ARI, Mr. GIORA GISSIS (Bet Ushishkin Museum, Qibbutz Dan), the late Mr. ZEEV SHOAM (Qibbutz Neot Mordachai), and particularly BENNI & ALIZA BEN DAVID of Kefar Sabba. We are most grateful to Dr. L. SCHNUR and A. PHILLIPS for revising the manuscripts. This study would not have been possible without the generous help of Prof. Y. SCHLEIN, Hebrew University, Hadassah En Karem Medical School.

References

- AMSEI, H.G. (1933): Die Lepidopteren Palästinas. Eine zoogeographisch-ökologisch-faunistische Studie. - Zoographica 2: 1-146, Verlag von Gustav Fischer, Jena.
- AMSEL, H. G. (1935a): Neue palaestinensische Lepidopteren. - Mitt. Zool. Mus. Berlin 20: 271-319, Berlin.
- AMSEL, H. G. (1935b): Weitere Mitteilungen ueber palaestinensische Lepidopteren. - Veroeffentl. Dt. Kolonial- und Uebersee-Mus., Bremen 1: 223-277, Bremen.
- ASHBEL, D. (1951): Bio-climatic atlas of Israel. - Meteorology Dept. of the Hebrew University. Jerusalem (Hebrew and English).
- AVIDOV, Z. & I. HARPAS (1969): Plant pests of Israel. - Israel Universities Press, Jerusalem.
- BIEL, E. R. (1944): Climatology of the Mediterranean area. - Chicago.
- BODENHEIMER, F. S. (1930): Die Schaedlingsfauna Palaestinas. - Verlag Paul Parey, Berlin.
- BODENHEIMER, F. S. (1935): Animal life in Palestine. - L. Mayer, Cairo.
- BODENHEIMER, F. S. (1939): Prodrum faunae palaestinae. - Mem. Inst. Egypt 33: 1-286, Cairo.
- BYTINSKI-SALZ, H. (1961). The Ethiopian element in the insect fauna of Israel. Proc. 11th International Congress of Entomology: 457-463, Vienna.
- BYTINSKI-SALZ, H. & M. STERNLICHT (1967): Insects associated with oaks (*Quercus*) in Israel. - Israel Journal of Entomology 2: 107-143, Jerusalem.
- FREINA, J. DE & TH. WITT (1987): Die Bombyces und Spingines der Westpalaearktis, Bd. 1. Edition Forschung und Wissenschaft, München.
- FURTH, D. G. (1975): Israel, a great biogeographic crossroad. - Discovery 11: 3-13. Peabody Museum of Natural History, Yale University, New Haven. y Museum of Natural History, Yale University, New Haven.
- HACKER H. H. (2001a): Fauna of the Nolidae and Noctuidae of the Levant with description and taxonomic notes (Lepidoptera, Noctuoidea). - Esperiana 8: 7-398, Schwanfeld.
- HACKER H. H. & H.-P. SCHREIER (2001b): List of Noctuoidea (Lepidoptera) collected from 1987 to 1999 in Israel and Jordan. - Esperiana 8: 423-458, Schwanfeld.
- HALPERIN, J. & W. SAUTER (1991): An annotated list with new records of Lepidoptera associated with forest and ornamental trees and shrubs in Israel. - Israel J. Ent. 25-26: 105-147, Jerusalem.
- JAFFE, S. (1988): Climate of Israel, in: YOM-TOV, Y. & E. TCHERNOV (Eds), The Zoogeography of Israel. The Distribution and Abundance at a Zoogeographical Crossroads: 79-95, Dr. W. Junk Publishers, Dordrecht.
- KOSSWIG, C. (1955): Zoogeography of the Near East. - Syst. Zool. 4: 49-73, Washington, D. C.
- KRISTENSEN, N. P. (1999): Lepidoptera, moths and butterflies. Vol. 1, in: Handbook of Zoology. Maximilian Fischer ed., Walter de Gruyter, New York.
- KUGLER, J. (1988): The zoogeography of social insects of Israel and Sinai, in: YOM-TOV, Y. & E. TCHERNOV (Eds), The Zoogeography of Israel. The Distribution and Abundance

- at a Zoogeographical Crossroads: 251–277, Dr. W. Junk Publishers, Dordrecht.
- KUGLER, J. (1989): Insects. In: A. ALON (Edit.): Plant and animals of the land of Israel. Vol. 3.
- Ministry of Defense Publishing House & Society of Protection of Nature, Israel.
- ORNI, E. & E. EFRAT (1980): Geography of Israel. 4th edition. - Israel Universities Press, Jerusalem.
- SCOBLE, M. J. (1992). The Lepidoptera: form, function, and diversity. - Oxford Univ. Press.
- WILTSHIRE, E. P. (1948): The Lepidoptera of the Kingdom of Egypt. - Bull. Soc. Fouad. I. Ent.
32: 203-294, Cairo.
- WILTSHIRE, E. P. (1951): Further new records of Lepidoptera of Cyprus, Iraq and Persia (Iran).
Ent. Rec. J. Var. 63: 1-6, London.
- WILTSHIRE E.P. (1957): The Lepidoptera of Iraq. - Nicholas Kaye Ltd, London & Baghdad.
- WILTSHIRE E.P. (1990): An Illustrated, Annotated Catalogue of the Macro-Heterocera of Saudi Arabia. - Fauna of Saudi Arabia 11: 91-250, Pro Entomologia, Basle.
- ZOHARY, M. (1962): Plant life of Palestine. - New York.
- ZOHARY, M. (1966): Flora Palaestina Part I text. The Israel Academy of Sciences and Humanities,
Jerusalem.
- ZOHARY, M. (1972): Flora Palaestina Part II. The Israel Academy of Sciences and Humanities,
Jerusalem.
- ZOHARY, M. & G. ORSHANSKY (1949): Structure and ecology of the vegetation in the Dead Sea
region of Palestine. - Palest. J. Bot. 4: 177, Jerusalem.